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The Program FEM3D
Users Manual

by

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Department or group

Reactor Technology

Group's own registration number(s)

RT-10-14

pages + tables + illustrations

Abstract

This report contains a short description of the program FEM3D.

The program solves the three-dimensional multigroup neutron diffusion equation by the finite element method.

The elements are box-formed Lagrange type elements of order 1, 2, or 3.

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CONTENTS

SHORT DESCRIPTION

FEM3D is a finite element program for approximate solution of the diffusion-theory-equation

$$(1) \quad -\nabla(D_g(\underline{r})\nabla\phi_g(\underline{r})) + \Sigma_{r,g}(\underline{r})\phi_g(\underline{r}) -$$

$$-\sum_{g'\neq g} \Sigma_{s,g\leftarrow g'}(\underline{r})\phi_{g'}(\underline{r}) - \frac{1}{K_{eff}} \cdot \chi_g(\underline{r}) \sum_{g'} (\nu\Sigma_f)_{g'}(\underline{r})\phi_{g'}(\underline{r}) = 0$$

within a domain Ω in the three dimensional space with the boundary conditions

$$(2) \quad \frac{\partial\phi_g(\underline{r})}{\partial\underline{n}} = L_g(\underline{r})\phi_g(\underline{r})$$

Ω is divided in box-formed elements. Within each element the flux $(\phi_g(\underline{r}))$ is approximated by a polynomial of order m.

For more details about the method and the approximation used see ref. 1-3.

The equations are solved for one group at a time using the ordinary power iteration technique. The equation for one group is solved by a pointvise successive overrelaxation technique.

The iterations are accelerated by either ordinary or Chebyshev extrapolation.

For details concerning the Chebyshev extrapolation see ref. 4.

The iterations are stopped when the local error is less than a given input parameter (eps).

An approximate upper limit for the local error $(\varepsilon_{1,max})$ is calculated in this way:

$$\varepsilon_{1,max} \leq \frac{\max |\phi_i^k - \phi_i^{k-1}|}{\max \phi_i^k} \cdot \text{extpl}$$

where k gives the outer iteration number, i runs over all flux points in all groups and extpl is the maximal of the last three extrapolation factors used for ordinary extrapolation.

APPLICATION

The program gives very reliable results within reasonable calculation times, but it is not a fast program and should therefore mostly be used where high precision is needed.

The typical precision of a calculation with the program can be seen in ref. 1.

INPUT SPECIFICATION

The input parameters are listed in the order in which they appear, each followed by a short explanation.

$\left.\begin{array}{l}\text{FF:}\\ \text{Problem no.:}\\ \text{day, month, year:}\end{array}\right\}$ administration input

CMX: number of coarse mesh in the x-direction.

CMY: number of coarse mesh in the y-direction.

CMZ: number of coarse mesh in the z-direction.

NCP: number of compositions=number of ordinary materials + number of boundary conditions.

NB: number of boundary conditions.

NG: number of groups.

M: gives the order of the interpolation polynomial, for practical reasons M should be less than or equal to 3.

SAVE: if SAVE=0 no saving of flux vectors and the matrix is performed.

if SAVE=n the matrix and other necessary variables are saved just before begin of the power iteration. The file is named FEM3DTAPEH.

The flux vectors for all groups are saved after after 1, n+1, 2n+1,... iterations on FEM3DTAPE2.

if SAVE=-n the matrix and other necessary variables are read from FEM3DTAPEN and the group flux vectors from FEM3DTAPE1 before the power iteration starts. The flux vectors for all groups are saved after 1, n+1, 2n+1,... iterations on FEM3DTAPE2.

TAPE: number of tape stations, which can be used in the sorting phase. If enough space is available on disk or pack no tapes are used.

CORE: available core for the sorting phase, standard algol sort is utilized. 12000 words is a reasonable space.

DSK: available space on the system disk (head per track disk), if DSK > 600000 the sorting phase will use the system resource pack rather than the system disk.

MX: the maximal number of fine mesh in the x-direction.

MY: the maximal number of fine mesh in the y-direction.

MZ: the maximal number of fine mesh in the z-direction.

XC: array (0: CMX), containing the coordinates of the coarse mesh division in the x-direction.

FMX: array (1: CMX), gives the number of fine mesh into which each coarse mesh is divided before the calculation.

YC: array (0: CMY), containing the coordinates of the coarse mesh division in the y-direction.

FMY: array (1: CMY), gives the number of fine mesh into which each coarse mesh is divided before the calculation.

ZC: array (0: CMZ), containing the coordinates of the coarse mesh division in the z-direction.

FMZ: array (1: CMZ), gives the number of fine mesh into which each coarse mesh is divided before the calculation.

CMP: array (0: CMX+1, 0: CMY+1, 0: CMZ+1), containing lay-out of composition numbers. The composition is read as a number of planes perpendicular to the z-direction. The first plane corresponding to the highest (last in ZC) z-coordinate. Within each plane the numbers are read as if they form part of the first quadrant in the xy-plane.

Diffusion data for the NCP compositions:

K: composition number.

<u>For $K \le NB$</u>

EXTPL: array (1:NG) current/flux ratios for the NG groups at the boundary characterized by the composition number K.

<u>For $NB < K \le NCP$:</u>

Data for the ordinary material, characterized by the composition number K.

D: array (1:NG) diffusion coefficient for the groups.

SS: the modified scattering matrix

$$SS(g,g) = \Sigma_{r,g} = \Sigma_{abs,g} + \sum_{g \neq g'} \Sigma_{s,g' \leftarrow g}$$

$$SS(g,g') = \Sigma_{s,g \leftarrow g'}$$

FS: array (1:NG) normalised fission spectrum.

NFS: array (1:NG), $\nu\Sigma_{fiss}$.

control variables for the power iteration:

MAXANTALITERATIONER: the maximal number of iterations.

EPS: the iterations are stopped when the local error ($\varepsilon_{1,max}$, calculated as described on page 3) is less than eps.

EPSMY: extrapolation is performed when the relative change in the extrapolation factor for two consecutive iterations is less than EPSMY.

OMEGA: overrelaxation factor for all groups during the first STARTIT iterations, one inner per outer iteration.

OMEGAINDRE: array (1:NG), overrelaxion factors for the inner iterations in the groups.

INFAC: the inner iterations are stopped when the residue in the inner iteration is the factor INFAC less than the last outer residue *MY. MY is an approximation to the ratio between the second largest and the largest eigenvalue, see output explanation.

MAXINDREIT: the maximal number of inner iterations fro each group and each outer iteration.

PIN: if <u>PIN=1</u> information is printed concerning the inner iterations.

CHEBY: if <u>CHEBY=1</u> Chebyshev acceleration is performed.

if <u>CHEBY≠1</u> normal exstrapolation is used.

STARTIT: the first STARTIT iterations are performed with one inner per outer iteration and no extrapolation.

SIG: assumed ratio between the two largest eigenvalues, used in the Chebyshev extrapolation, see ref. 4.

SIGMAX: if the calculated approximation to SIG exceeds SIGMAX, the Chebyshev extrapolation is stopped.

ANTCHB: the maximum number of iteration with Chebyshev acceleration.

RESTART: during the program execution information about the possibility for restart is written on the output file. If the execution is stopped after the restart number 1 or 2 have been written, the execution can be restarted from the latest restart point. The program is run with the same input as before, except RESTART = 1 or 2. After normal termination of the program, no restart is possible, but the iterations can be continued if SAVE≠0.

The input is now concluded with the administration input cards FF and -1 or a new problem.

Quick reference input specification

Each line in the following corresponds to one logical record and must start on a new card.

Repeated equally structured data is shown as [data]·N where N gives the number of repeats.

FF
problem } administration-input
day, month, year
cmx, cmy, cmz, ncp, nb, ng, m, save, tape, core, dsk
mx, my, mz
xc(0), xc(1), ..., xc(cmx)
fmx(1), fmx(2), ..., fmx(cmx)
yc(0), yc(1), ..., yc(cmy)
zc(0), zc(1), ..., zc(cmz)
fmz(1), fmz(2), ..., fmz(cmz)

$$\left[\begin{array}{l} \mathrm{cmp}(0,\mathrm{cmy}+1,z),\ \mathrm{cmp}(1,\mathrm{cmy}+1,z),\ \ldots,\ \mathrm{cmp}(\mathrm{cmx}+1,\ \mathrm{cmy}+1,z) \\ \mathrm{cmp}(0,\mathrm{cmy},z),\ \mathrm{cmp}(1,\mathrm{cmy},z),\ \ldots,\ \mathrm{cmp}(\mathrm{cmx}+1,\ \mathrm{cmy},z) \\ \quad\quad\cdot \\ \quad\quad\cdot \\ \quad\quad\cdot \\ \mathrm{cmp}(0,0,z),\ \mathrm{cmp}(1,0,z),\ \ldots,\ \mathrm{cmp}(\mathrm{cmx}+1,0,z) \end{array}\right] \cdot (\mathrm{cmz}+2)$$

z=cmz+1, cmz, ...,0
each z-value corresponds
to one logical record

$$\left[\begin{array}{l} k \\ \mathrm{extpl}(1),\ \mathrm{extpl}(2),\ \ldots,\ \mathrm{extpl}(ng) \end{array}\right] \cdot\ nb;\ 1 \le k \le nb$$

$$\left[\begin{array}{l} k \\ d(1),\ d(2),\ \ldots,\ d(ng) \\ ss(1,1),\ ss(1,2),\ \ldots,\ ss(1,ng),\ \ldots.\ ss(ng,\ ng) \\ fs(1),\ fs(2),\ \ldots,\ fs(ng) \\ nfs(1),\ nfs(2),\ \ldots,\ nfs(ng) \end{array}\right] \begin{array}{l} nb \le k \le ncp \\ \\ \cdot\ (ncp-nb) \\ \\ \\ \end{array}$$

maxantaliterationer, eps, epsmy, omega
omegaindre(1), omegaindre(2), ..., omegaindre(ng)
infac, maxindreit, pin, cheby, startit
sig, sigmax, antclsb
restart

$$\left.\begin{array}{l} \text{FF} \\ \text{-1 (or a new problem} \end{array}\right\} \text{ administration input}$$

OUTPUT DESCRIPTION

Each logical page starts with the usual ADM heading and can consists of several physical pages.

Page 1 is a listing of input in the order in which it is read, one logical record is read at a time and immediately written, except for the composition numbers, which are all read before they are written on the output.

The composition of the fine mesh (the mesh used in the calculation is also listed.

Page 2, Page 3, and Page 4 lists the time when the generation of the matrix starts, when the sorting starts and finally when the sorting is finished.

If SAVE<0 page 2, 3 and 4 are omitted.

If RESTART=1 page 2 and 3 are omitted.

If RESTART=2 page 2, 3, and 4 are omitted.

Page 5 (if save<0 or restart $\neq$ 0 the page number is 2 or 3) starts with a listing of some control variables of minor interest for the ordinary user, they are:

OANTAL: number of compositions = NCP.

RTYPER: number of boundaries = NB.

GANTAL: number of groups.

EANTAL: number of elements = number of meshes with ordinary materials.

RANTAL: number of external boundaries.

ANTALUBK: number of unknowns per group.

MAXHUD: (ng+1)·maxhud is the amount of space used for the matrix.

ANTALBLK: the number of blocks used for the equations on secondary storage. maxhud/1800 gives the minimum number of blocks, if antalblk is much greater, contact the person responsible for the program.
The maximum allowed number of blocks is 4500/ng (if ng = 1: 4500/2), if more space is needed contact responsible engineer.

After these control variables comes the progress report for the iteration.

IT.NR: the number of the iteration

DMAX/MAXFLUX: $\dfrac{\max|\emptyset_i^k-\emptyset_l^{k-1}|}{\max\ \emptyset_i^k}$; k gives iteration number, i runs over all flux-points in all groups

RESIDUE: $\dfrac{\Sigma|\emptyset_i^{k-1}-\emptyset_i^k|}{\max\emptyset_i^k \times n}$; n=total number of flux-points in all groups; i and k as above

RATIO: $\dfrac{\sum_i|\emptyset_i^{k-1}-\emptyset_i^k|/\max\emptyset_i^k}{\sum_i|\emptyset_i^{k-1}-\emptyset_i^{k-2}|} \times \mathrm{sign}(\emptyset_j^k-\emptyset_j^{k-1}) \times \mathrm{sign}(\emptyset_j^{k-1}-\emptyset_j^{k-2})$;

i and k as above

$$|\emptyset_j^{k-1}-\emptyset_j^{k-2}| = \max\ |\emptyset_i^{k-1}-\emptyset_i^{k-2}| \ ;$$

LAMBDA: $1/k_{eff}$

KEFF: k_{eff}

DELTAKEFF: $(k_{eff}^k-k_{eff}^{k-1})$

TOTALKILDE: $\sum_e \sum_g (\int_e \emptyset_g (\nu\Sigma_f)_g \, d\Omega))$

e runs over all elements
g runs over all groups

Every time an extrapolation is performed MY and eksfac is written

MY: =RATIO

EKSFAC: 1/(1-MY)

if PIN=1 the residue for each inner iterations is written between the outer iterations.

if CHEBY=1 information concerning the Chebyshev extrapolation is written, it consists of:

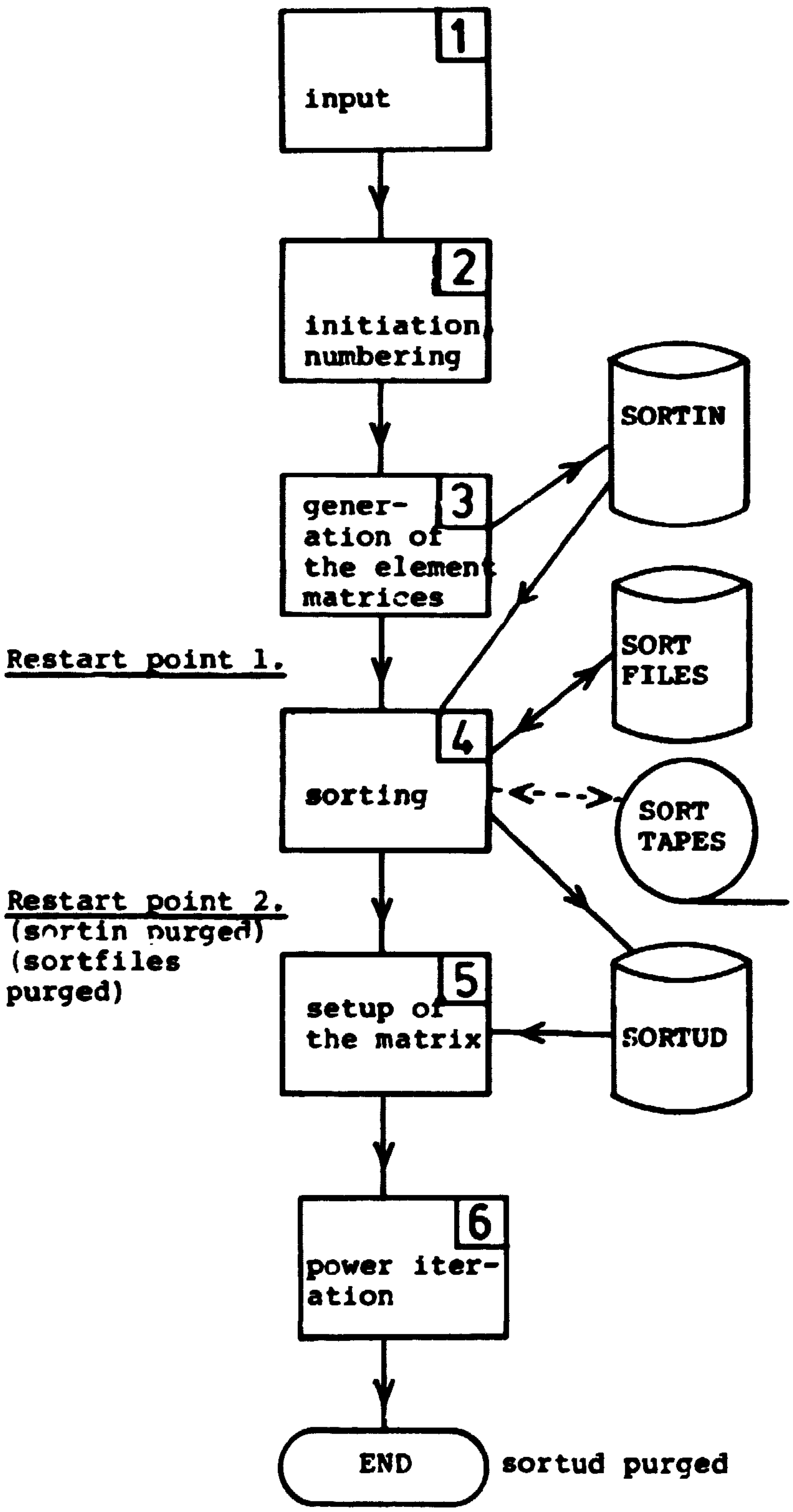
NCHEBY: number of the Chebyshev extrapolation
ALFA: α, see ref. 4
BETA: β, see ref. 4
SIGNEW: σ, see ref. 4, input parameter
SIGOUTER: calculated approximation to σ

Page 6 (3 or 4) the resulting k_{eff} value.

Page 7 (4 or 5) the calculated fluxdistribution normalised so that $\emptyset_{max}$=9999.

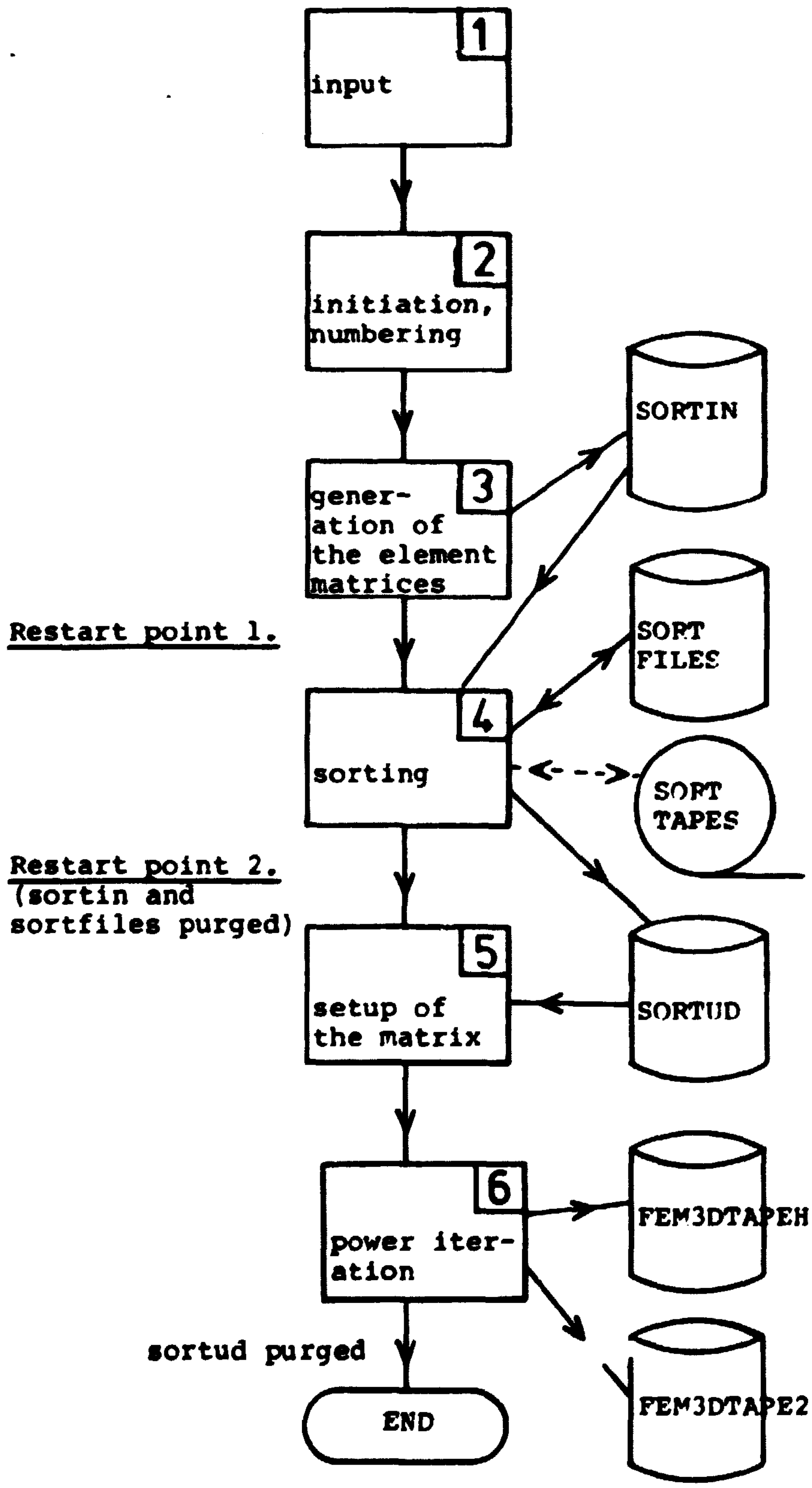
FILE CONFIGURATION FOR DIFFE- RENT CALCULATIONS

First calculation with no continuation possibility



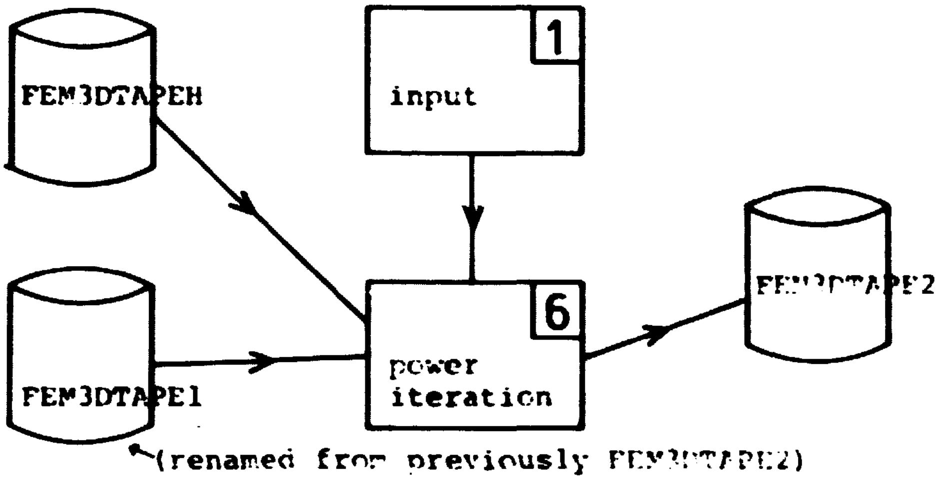
First calculation with continuation possibility

SAVE>0, RESTART=0



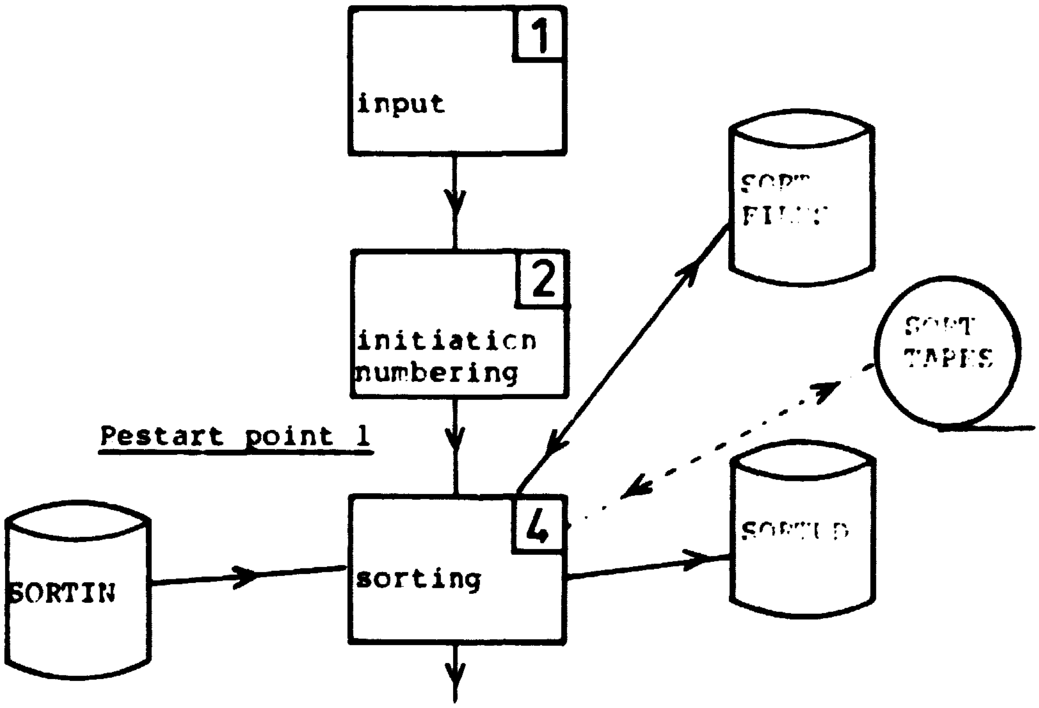
Second (and following) calculation

SAVE<0, RESTART=0



Calculation starting at restart point 1

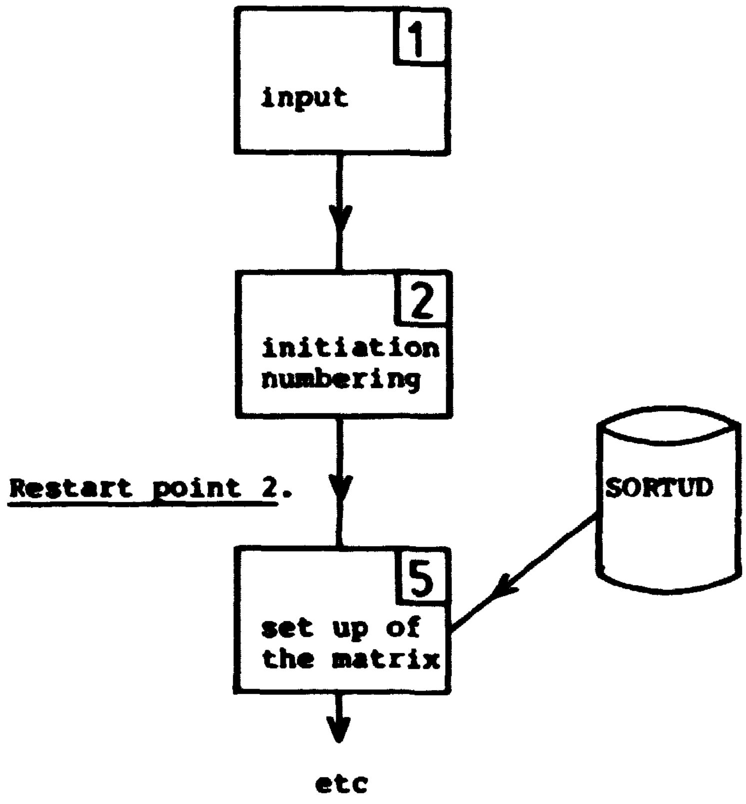
RESTART=1, first calculation failed during the sorting phase



etc.

Calculation starting at restart

RESTART=2, first calculation failed during
the set up phase or during the power iteration



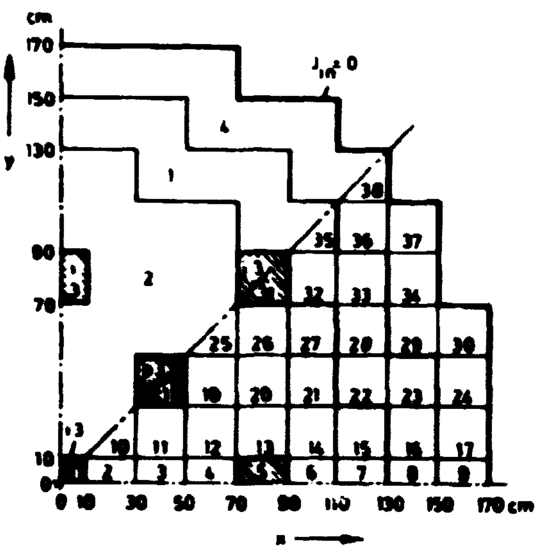
EXAMPLE

As an example on the use of the program a calculation have been performed on the 3D IAEA Benchmark problem, figure 1 from ref. 5 gives a short description of the problem.

The calculation is with the coarse mesh and a first order approximation.

A complete list of the run is shown as appendix A.

The output from this calculation is shown as appendix B.

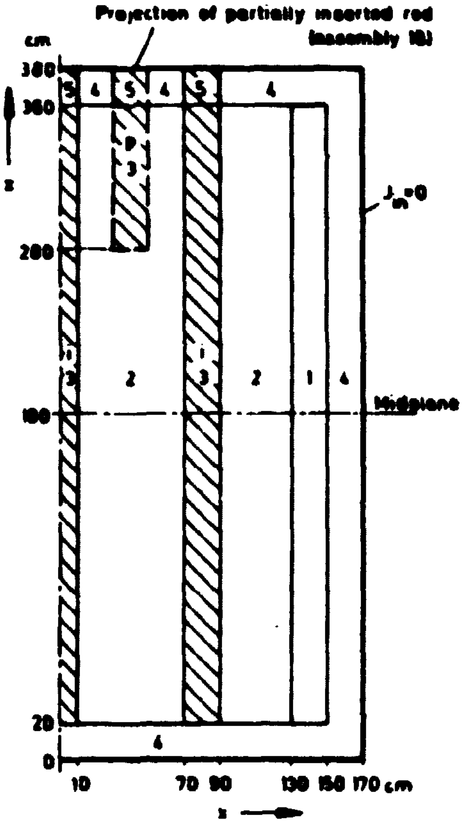


Upper Octant: Region Assignments
Lower Octant: Fuel Assembly Identification

Boundary Conditions:

External Boundaries $J^g_{in} = 0$

Symmetry Boundaries $J^g_{net} = 0$



Vertical Cross Section, y = 0

Group Constants for 3D IAEA Benchmark Problem

Region	D_1	D_2	$\Sigma_{1\to2}$	Σ_{a1}	Σ_{a2}	$\nu\Sigma_{f2}$	
1	1.5	0.4	0.02	0.01	0.08	0.135	Fuel 1
2	1.5	0.4	0.02	0.01	0.085	0.135	Fuel 2
3	1.5	0.4	0.02	0.01	0.13	0.135	Fuel 2 + Rod
4	2.0	0.3	0.04	0	0.01	0	Reflector
5	2.0	0.3	0.04	0	0.055	0	Refl. + Rod

$\chi_1 = 1.0$, $\chi_2 = 0.0$, $\nu\Sigma_{f1} = 0$ all regions

Note: 2D IAEA Benchmark Problem represents midplane z = 190 cm with constant axial buckling $B_z^2 = 0.8 \times 10^{-4}$ for all regions and energy groups

Fig. 1. 3D IAEA Benchmark Problem Specification

REFERENCES

1. I. Misfeldt, Solution of the Multigroup Neutron Diffusion Equation by the Finite Element Method.

2. The application of the Finite Element Method to the multigroup neutron diffusion equation, Nuclear Science and Engineering 47. By L.A. Semanza et al.

3. The Finite Element Method in Engineering Science by O.C. Zienkewicz.

4. G.K. Kristiansen, Description of DC-2, a two-dimensional, cylindrical geometry, two-group diffusion theory code for DASK, and a discussion of the theory for such codes. Risø Report No. 55, January 1963.

5. M.R. Wagner, Current trends in multidimensional static reactor calculations, in Proceedings of the conference on Computational Methods in Nuclear Engineering, April 15-17, Charleston, USA.

APPENDIX A

A complete card deck for a calculation on the example shown on page 17.

The calculation is performed with a coarse mesh, 9 mesh in the x and y directions and only 4 mesh in the z-direction.

Output from this job is shown as appendix B.

```
:JOB BT/MISFIT;CLASS=0;CHARGE=2510028;USER=WIMISFELDT/WORK
:PROCESSTIME=1800;IOTIME=1200; PRINTLIMIT=5000;
:DESTNAME=SITE
:BEGIN RUN OBJECT/FEM3D
:DATA INDATA
```

```
FF                                                  } administration input
25.
08.11.1977.
9.9.4.7.2.2.1.05.0.12000.500000.                    } control variables
9.9.4.
0.10.30.50.70.90.110.130.150.170.
1.1.1.1.1.1.1.1.1.                                  } mesh specification
0.10.30.50.70.90.110.130.150.170.
1.1.1.1.1.1.1.1.1.
0.20.280.360.380.
1.1.1.1.1.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.1.1.1.1.1.1.1.1.1.1.

1.2.2.2.2.2.2.2.2.2.2.
1.6.6.6.6.2.2.2.2.2.2.
1.6.6.6.6.6.6.2.2.2.2.
1.6.6.6.6.6.6.6.2.2.2.
1.6.6.6.6.6.6.6.6.2.2.
1.7.6.6.6.7.6.6.6.2.2.
1.6.6.6.6.6.6.6.6.6.2.
1.6.6.7.6.6.6.6.6.6.2.
1.6.6.6.6.6.6.6.6.6.2.
1.7.6.6.6.7.6.6.6.6.2.
1.1.1.1.1.1.1.1.1.1.1.

1.2.2.2.2.2.2.2.2.2.2.
1.6.6.6.6.2.2.2.2.2.2.
1.3.3.3.6.6.6.2.2.2.2.                              } composition numbers
1.4.4.3.3.3.6.6.2.2.2.                                (blank lines are inserted
1.4.4.4.4.3.3.6.6.2.2.                                between each xy-slab)
1.5.4.4.4.5.3.3.6.2.2.
1.4.4.4.4.4.4.3.6.6.2.
1.4.4.5.4.4.4.3.3.6.2.
1.4.4.4.4.4.4.4.3.6.2.
1.5.4.4.4.5.4.4.3.6.2.
1.1.1.1.1.1.1.1.1.1.1.

1.2.2.2.2.2.2.2.2.2.2.
1.6.6.6.6.2.2.2.2.2.2.
1.3.3.3.6.6.6.2.2.2.2.
1.4.4.3.3.3.6.6.2.2.2.
1.4.4.4.4.3.3.6.6.2.2.
1.5.4.4.4.5.3.3.6.2.2.
1.4.4.4.4.4.4.3.6.6.2.
1.4.4.4.4.4.4.3.3.6.2.


1.4.4.4.4.4.4.4.3.6.2.
1.5.4.4.4.5.4.4.3.6.2.
1.1.1.1.1.1.1.1.1.1.1.
```

```
1.2.2.2.2.2.2.2.2.2.2.
1.6.6.6.6.2.2.2.2.2.2.
1.6.6.6.6.6.6.2.2.2.2.
1.6.6.6.6.6.6.6.2.2.2.
1.6.6.6.6.6.6.6.6.2.2.
1.6.6.6.6.6.6.6.6.2.2.
1.6.6.6.6.6.6.6.6.6.2.
1.6.6.6.6.6.6.6.6.6.2.
1.6.6.6.6.6.6.6.6.6.2.
1.6.6.6.6.6.6.6.6.6.2.
1.1.1.1.1.1.1.1.1.1.1.

1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.2.2.2.2.2.2.2.2.2.2.
1.1.1.1.1.1.1.1.1.1.1.
```

composition numbers cont.

```
1
0.0
2
0.467.0.467.
```

boundary conditions

```
3
1.5.0.4
0.03.0.0.0[illegible].0[illegible].0.0[illegible]
1.0
0.0.135
4
1.5.0.4
0.03.0.0.02.0.085
1.0.0
0.0.135
5
1.5.0.4
0.03.0.0.02.0.13
1.0.0
0.0.135
6
2.0.0.3
0.04.0.0.04.0.01
1.0
0.0.0.0
7.
2.0.3
0.04.0.0.04.0.0[illegible].
1.0
0.0
```

ordinary materials

```
100.E-4.0.05.1.1.
1.1.1.1.
10.1.0.0.10.
 0.06.1.10.
```

control variables for the iterations

```
0
```

restart specification

```
FF
-1.
:END JOB
```

administration input

APPENDIX B

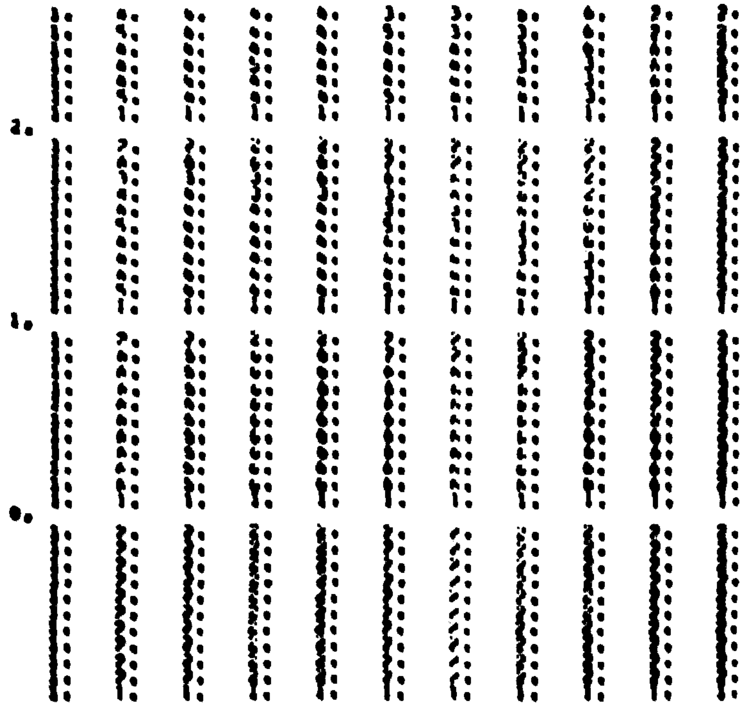
Output from the example.

```
                                                      -1-                                       COMPILED: 10/11-1977.    11:41
                                                                                                11/11-1977.   23:36
                                                                                                PROCESSOR    =    0 SEC
                                                                                                ELAPSED      =    1 SEC
A.E.K. PROGRAM NO. 25     PROBLEM NO. 25    8/11.1977                                           INPUT/OUTPUT=     0 SEC
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

  CMX   CMY   CMZ   MCP   NB    NG    M  SAVE  TAPE  CONE   DSK
   9.    9.    4.    7.    2.    2.   1.   5.    0.  12000. 500000.
    NX    NY    NZ
    9.    9.    4.
XC
  0.          1.000E+01  3.000E+01  5.000E+01  7.000E+01  9.000E+01  1.100E+02  1.300E+02  1.500E+02  1.700E+02
FMX
       1.          1.         1.         1.         1.         1.         1.         1.         1.
YC
  0.          1.000E+01  3.000E+01  5.000E+01  7.000E+01  9.000E+01  1.100E+02  1.300E+02  1.500E+02  1.700E+02
FMY
       1.          1.         1.         1.         1.         1.         1.         1.         1.
ZC
  0.          2.000E+01  2.000E+02  3.600E+02  3.800E+02
FMZ
       1.          1.         1.         1.
```

COMPOSITIONS NUMBERS

5.	1.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	1.	1.	[illegible]	1.	1.	1.	[illegible]	[illegible]	[illegible]	[illegible]
4.	1.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	1.	1.	1.	1.	1.	1.	1.	1.	[illegible]	[illegible]
3.	1.	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1.	4.	4.	3.	3.	3.	4.	6.	[illegible]	[illegible]	[illegible]



1
CXTPL: 0.   0.

2
CXTPL: 0.67003E-01 0.67004E-01

3

```
    D: 1.50000E+00 4.00000E-01
   SS: 3.00000E-02 0.            2.00000E-02 8.00000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          1.35000E-01


4

    D: 1.50000E+00 4.00000E-01
   SS: 3.00000E-02 0.            2.00000E-02 8.50000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          1.35000E-01


5

    D: 1.50000E+00 4.00000E-01
   SS: 3.00000E-02 0.            2.00000E-02 1.30000E-01
   FS: 1.00000E+00 0.
  NFS: 0.          1.35000E-01


6

    D: 2.00000E+00 3.00000E-01
   SS: 4.00000E-02 0.            4.00000E-02 1.00000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          0.


7

    D: 2.00000E+00 3.00000E-01
   SS: 4.00000E-02 0.            4.00000E-02 5.50000E-02
   FS: 1.00000E+00 0.
  NFS: 0.          0.


MAXANTALITERATIONER         EPS            EPSHY           OMEGA
             101.      1.0000E-04     5.0000E-02      1.1000E+00

OMEGAINDRE:         1.10      1.10
```

```
INFAC:       10.00   MAXINDREIT:          1.    PIN:    0.    CHEBY:    0.    STARTIT:   10.

SIG.SIGMAX.ANTCHB:        0.960      1.000     10.000

COMPOSITION AFTER THE FINE-MESH DIVISION
```

```
THE SLAB FROM Z=  360      TO Z=  360
170. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
170. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
150. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
130. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
110. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
 90. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
 70. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
 50. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
 30. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
 10. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
  0. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   1 !   1 !   1 !   1 !   1 !   1 !   1 !   1 !   1 !   1 !
  0. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      0.    0.   10.   30.   50.   70.   90.  110.  130.  150.  170.  170.
```

```
THE SLAB FROM Z=  360      TO Z=  360
170. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !   2 !
170. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   6 !   6 !   6 !   6 !   2 !   2 !   2 !   2 !   2 !   2 !
150. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   6 !   6 !   6 !   6 !   6 !   6 !   2 !   2 !   2 !   2 !
130. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      !   1 !   6 !   6 !   6 !   6 !   6 !   6 !   6 !   2 !   2 !   2 !
110. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

```
      !  1 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  2 !  2 !
 90.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  7 !  6 !  6 !  6 !  7 !  6 !  6 !  6 !  2 !  2 !
 70.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  2 !
 50.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  6 !  6 !  7 !  6 !  6 !  6 !  6 !  6 !  6 !  2 !
 30.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  6 !  2 !
 10.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  7 !  6 !  6 !  6 !  7 !  6 !  6 !  6 !  6 !  2 !
  0.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !
  0.  +----+----+----+----+----+----+----+----+----+----+----+

      0.   0.  10.  30.  50.  70.  90. 110. 130. 150. 170. 170.
```

THE SLAB FROM Z= 280 TO Z= 360

```
170.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !
170.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  6 !  6 !  6 !  6 !  2 !  2 !  2 !  2 !  2 !  2 !
150.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  3 !  3 !  3 !  6 !  6 !  6 !  2 !  2 !  2 !  2 !
130.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  4 !  4 !  3 !  3 !  3 !  6 !  6 !  2 !  2 !  2 !
110.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  4 !  4 !  4 !  4 !  3 !  3 !  6 !  6 !  2 !  2 !
 90.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  5 !  4 !  4 !  4 !  5 !  3 !  3 !  6 !  2 !  2 !
 70.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  4 !  4 !  4 !  4 !  4 !  4 !  3 !  6 !  6 !  2 !
 50.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  4 !  4 !  5 !  4 !  4 !  4 !  3 !  3 !  6 !  2 !
 30.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  4 !  4 !  4 !  4 !  4 !  4 !  4 !  3 !  6 !  2 !
 10.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  5 !  4 !  4 !  4 !  5 !  4 !  4 !  3 !  6 !  2 !
  0.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !  1 !
  0.  +----+----+----+----+----+----+----+----+----+----+----+

      0.   0.  10.  30.  50.  70.  90. 110. 130. 150. 170. 170.
```

THE SLAB FROM Z= 20 TO Z= 280

```
170.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !  2 !
170.  +----+----+----+----+----+----+----+----+----+----+----+
      !  1 !  6 !  6 !  6 !  6 !  2 !  2 !  2 !  2 !  2 !  2 !
150.  +----+----+----+----+----+----+----+----+----+----+----+
```

```
       !  1  !  3  !  3  !  3  !  6  !  6  !  6  !  2  !  2  !  2  !  2  !
 130.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  4  !  4  !  3  !  3  !  3  !  6  !  6  !  2  !  2  !  2  !
 110.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  4  !  4  !  4  !  4  !  3  !  3  !  6  !  6  !  2  !  2  !
  90.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  5  !  4  !  4  !  4  !  5  !  3  !  3  !  6  !  2  !  2  !
  70.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  4  !  4  !  4  !  4  !  4  !  4  !  3  !  6  !  6  !  2  !
  50.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  4  !  4  !  4  !  4  !  4  !  4  !  3  !  3  !  6  !  2  !
  30.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  4  !  4  !  4  !  4  !  4  !  4  !  4  !  3  !  6  !  2  !
  10.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  5  !  4  !  4  !  4  !  5  !  4  !  4  !  3  !  6  !  2  !
   0.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !
   0.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

       0.    0.   10.   30.   50.   70.   90.  110.  130.  150.  170.  170.


THE SLAB FROM Z=    0      TO Z=   20
 170.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  2  !  2  !  2  !  2  !  2  !  2  !  2  !  2  !  2  !  2  !
 170.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  2  !  2  !  2  !  2  !  2  !  2  !
 150.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !  2  !  2  !  2  !
 130.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !  2  !  2  !
 110.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !  2  !
  90.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !  2  !
  70.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !
  50.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !
  30.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !
  10.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  6  !  2  !
   0.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
       !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !  1  !
   0.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

       0.    0.   10.   30.   50.   70.   90.  110.  130.  150.  170.  170.


THE SLAB FROM Z=    0      TO Z=    0
 170.  +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

```
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
170. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
150. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
130. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
110. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
 90. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
 70. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
 50. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
 30. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
 10. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I  2  I
  0. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
      I  1  I  1  I  1  I  1  I  1  I  1  I  1  I  1  I  1  I  1  I  1  I
  0. -+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

      0.    0.   10.   30.   50.   70.   90.  110.  130.  150.  170.  170.
```

A.E.K. PROGRAM NO. 25   PROBLEM NO. 25   8/11.1977
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

11/11-1977, 23.30
PROCESSOR = 2 SEC
ELAPSED = 5 SEC
INPUT/OUTPUT= 2 SEC

THE GENERATION OF THE M-MATRIX STARTS HERE

A.E.K. PROGRAM NO. 25   PROBLEM NO. 25   8/11.1977
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

11/11-1977.   23.37
PROCESSOR   = [illegible] SEC
ELAPSED   = 57 SEC
INPUT/OUTPUT = 5 SEC

THE ELEMENTS IN THE N-MATRIX ARE GENERATED

THIS IS RESTART POINT NO. 1 !!!

11/11-1977, 23.38
PROCESSOR = 102 SEC
ELAPSED = 120 SEC
INPUT/OUTPUT= 22 SEC

A.E.K. PROGRAM NO. 25 PROBLEM NO. 25 8/11.1977
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

THE SORT IS FINISHED

THIS IS RESTART POINT NO. 2 !!!

A.E.K. PROGRAM NO. 25 PROBLEM NO. 25 8/11.1977
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

11/11-1977. 23.39
PROCESSOR = [illegible] SEC
ELAPSED = [illegible] SEC
INPUT/OUTPUT= 27 SEC

UANTAL	PTYPER	GANTAL	EANTAL	RANTAL	ANTALVAR	MAXNOD	ANTALUER
7	2	2	276	282	500	4848	5

START ON THE POWER ITERATION

CONTINUED CALCULATION IS POSSIBLE AFTER SAVING HAVE BEEN PERFORMED (SAVE NOT EQUAL 0)

IT. NR	QMAX/MAXFLUX	RESIDUE	RATIO	LAMBDA	KEFF	DELTAKEFF	TOTALFLUX	
1	6.5060E-01	9.0513E-01	0.00000000	0.96329122	1.03010766	3.0100E-02	1.0426E+00	
2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
6	1.0103E-01	1.1001E-02	-0.04634075	0.97056501	1.03032084	-4.5031E-03	1.0494E+00	
7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
11	4.0023E-02	4.7097E-03	0.70529039	0.96609307	1.03504696	1.5603E-03	1.1465E+00	
12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
15	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
16	1.9036E-02	5.0727E-03	0.87440215	[illegible]	[illegible]	[illegible]	[illegible]	
17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
18	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
19	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
21	1.5159E-02	1.7420E-03	0.94927372	0.96076896	1.04041150	-6.7257E-04	1.1501E+00	
22	1.5393E-02	1.2474E-03	0.71570622	0.95705902	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
23	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
25	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
26	1.0567E-02	1.0060E-03	0.86495043	0.95723696	1.04467342	9.1744E-04	1.1570E+00	
27	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	SAVING OF FLUX AND KEFF
28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
29	8.6320E-03	8.7909E-04	0.87220705	0.95735717	1.04454223	8.2362E-04	1.1489E+00	

	30	8.3158E-03	8.4912E-04	0.96591198	0.95749720	1.04438947	-1.5276E-04	1.1590E+06
	31	7.8625E-03	8.3809E-04	0.98700575	0.95773642	1.04412862	-2.6086E-04	1.1594E+06
	SAVING OF FLUX AND KEFF							
	32	7.1961E-03	7.6721E-04	0.91542893	0.95741668	1.04447731	3.8869E-04	1.1605E+06
	33	6.8567E-03	7.1143E-04	0.92729879	0.95726176	1.04464635	1.6904E-04	1.1610E+06
	34	6.5251E-03	6.9139E-04	0.97182226	0.95739249	1.04450370	-1.4265E-04	1.1614E+06
	35	6.0096E-03	6.5657E-04	0.94964231	0.95733292	1.04456869	6.4990E-05	1.1621E+06
	36	5.5712E-03	6.1275E-04	0.93326356	0.95718671	1.04472826	1.5956E-04	1.1628E+06
	SAVING OF FLUX AND KEFF							
	37	5.2302E-03	5.8469E-04	0.95419621	0.95719469	1.04471955	-8.7127E-06	1.1633E+06
	38	4.9420E-03	5.5944E-04	0.95719643	0.95720648	1.04470668	-1.2867E-05	1.1639E+06
	39	4.5806E-03	5.2783E-04	0.94311637	0.95713557	1.04478407	7.7395E-05	1.1646E+06
	40	4.3162E-03	4.9996E-04	0.94720785	0.95710033	1.04482254	3.8466E-05	1.1652E+06
	41	4.1021E-03	4.7710E-04	0.95428501	0.95710704	1.04481522	-7.3224E-06	1.1658E+06
	SAVING OF FLUX AND KEFF							
	42	3.8364E-03	4.5274E-04	0.94892351	0.95708418	1.04484018	2.4960E-05	1.1665E+06
	43	3.5856E-03	4.2815E-04	0.94569436	0.95705382	1.04487375	3.3574E-05	1.1671E+06
	44	3.3818E-03	4.0655E-04	0.94954463	0.95704755	1.04488016	6.4095E-06	1.1678E+06
	45	3.1759E-03	3.8601E-04	0.94948777	0.95704172	1.04488653	6.3631E-06	1.1684E+06
	46	2.9664E-03	3.6520E-04	0.94629201	0.95702561	1.04490412	1.7596E-05	1.1691E+06
	SAVING OF FLUX AND KEFF							
	47	2.9294E-03	3.4588E-04	0.94688948	0.95701673	1.04491381	9.6938E-06	1.1698E+06
	48	2.9161E-03	3.2805E-04	0.94844413	0.95701431	1.04491646	2.6429E-06	1.1705E+06
NYI 0.948444		EL SFAC	19.396433					
	49	2.8105E-03	2.7067E-04	0.84948621	0.95702194	1.04490813	-8.3307E-06	1.1642E+06
	50	2.6994E-03	2.7409E-04	0.90356896	0.95694899	1.04498778	7.9649E-05	1.1652E+06
	51	2.5795E-03	2.5919E-04	0.94563778	0.95698814	1.04494503	-4.2746E-05	1.1660E+06
	SAVING OF FLUX AND KEFF							
	52	2.5000E-03	2.4505E-04	0.94542380	0.95703334	1.04489568	-4.9350E-05	1.1669E+06
	53	2.4155E-03	2.3680E-04	0.96633617	0.95701290	1.04491800	2.2316E-05	1.1878E+06
	54	2.3149E-03	2.2603E-04	0.96296816	0.95701154	1.04491948	1.4798E-06	1.1886E+06
	55	2.2284E-03	2.1826E-04	0.95715796	0.95703969	1.04488875	-3.0729E-05	1.1894E+06
	56	2.1518E-03	2.1028E-04	0.96346383	0.95704602	1.04488183	-6.9198E-06	1.1902E+06
	SAVING OF FLUX AND KEFF							
	57	2.0494E-03	2.0356E-04	0.96800609	0.95704280	1.04488535	3.5250E-06	1.1910E+06
	58	1.9890E-03	1.9656E-04	0.96564520	0.95705468	1.04487238	-1.2974E-05	1.1917E+06
	59	1.9170E-03	1.9017E-04	0.96749546	0.95706606	1.04485996	-1.2423E-05	1.1924E+06
	60	1.8466E-03	1.8524E-04	0.97403725	0.95706852	1.04485727	-2.6910E-06	1.1931E+06
	61	1.7764E-03	1.8036E-04	0.97369643	0.95707393	1.04485136	-5.9035E-06	1.1938E+06
	SAVING OF FLUX AND KEFF							
	62	1.7109E-03	1.7554E-04	0.97326246	0.95708288	1.04484159	-9.7692E-06	1.1944E+06
NYI 0.973262		EL SFAC	37.400604					
	63	2.1845E-03	1.9149E-04	1.09086808	0.95753956	1.04434327	-4.9832E-04	1.2175E+06
	64	2.2021E-03	1.6751E-04	0.87477990	0.95745475	1.04443578	9.2510E-05	1.2180E+06
	65	2.0560E-03	1.3653E-04	0.77923433	0.95720469	1.04470863	2.7285E-04	1.2183E+06
	66	1.9078E-03	1.3972E-04	1.07035361	0.95733378	1.04456776	-1.4088E-04	1.2181E+06
	SAVING OF FLUX AND KEFF							
	67	1.8602E-03	1.4620E-04	1.04640655	0.95742431	1.04446899	-9.8768E-05	1.2181E+06
	68	1.7839E-03	1.2688E-04	0.86785166	0.95730985	1.04459387	1.2488E-04	1.2184E+06
	69	1.6646E-03	1.1068E-04	0.93537638	0.95729173	1.04461365	1.9773E-05	1.2184E+06
	70	1.5841E-03	1.2396E-04	1.04446625	0.95735904	1.04454020	-7.3445E-05	1.2183E+06
	71	1.5215E-03	1.1731E-04	0.94632986	0.95734088	1.04456001	1.9812E-05	1.2185E+06
	SAVING OF FLUX AND KEFF							
	72	1.4341E-03	1.0793E-04	0.92007533	0.95730446	1.04459975	3.9737E-05	1.2185E+06
	73	1.3738E-03	1.0660E-04	0.98772574	0.95732469	1.04457768	-2.2073E-05	1.2185E+06
	74	1.3303E-03	1.0449E-04	0.98016980	0.95733597	1.04456536	-1.2311E-05	1.2185E+06
	75	1.2972E-03	9.8281E-05	0.94056933	0.95731829	1.04458466	1.9300E-05	1.2186E+06
	76	1.2729E-03	9.4276E-05	0.95924918	0.95731661	1.04458650	1.8315E-06	1.2186E+06
	SAVING OF FLUX AND KEFF							
	77	1.2439E-03	9.2225E-05	0.97825034	0.95732647	1.04457573	-1.0767E-05	1.2186E+06

78	1.2051E-03	8.8446E-05	0.95902201	0.95732346	1.04457901	3.2850E-06	1.2187E+06	
79	1.1712E-03	8.4690E-05	0.95752959	0.95731678	1.04458412	5.1097E-06	1.2187E+06	
80	1.1403E-03	8.2268E-05	0.97140912	0.95732250	1.04458006	-4.0626E-06	1.2187E+06	
81	1.1049E-03	7.9747E-05	0.96935084	0.95732456	1.04457782	-2.2454E-06	1.2187E+06	SAVING OF FLUX AND KEFF
82	1.0689E-03	7.6876E-05	0.96390275	0.95732260	1.04457987	2.0511E-06	1.2188E+06	
83	1.0356E-03	7.4438E-05	0.96829183	0.95732344	1.04457904	-6.3109E-07	1.2188E+06	
84	1.0017E-03	7.2288E-05	0.97112254	0.95732580	1.04457647	-2.5665E-06	1.2188E+06	
85	9.6676E-04	6.9973E-05	0.96797361	0.95732630	1.04457592	-5.4715E-07	1.2188E+06	
86	9.3293E-04	6.7623E-05	0.96926386	0.95732675	1.04457543	-4.8912E-07	1.2189E+06	SAVING OF FLUX AND KEFF
87	8.9968E-04	6.5893E-05	0.97154824	0.95732847	1.04457356	-1.8754E-06	1.2189E+06	
88	8.6662E-04	6.3969E-05	0.97080031	0.95732993	1.04457196	-1.5974E-06	1.2189E+06	
89	8.3362E-04	6.2042E-05	0.96988602	0.95733090	1.04457090	-1.0560E-06	1.2189E+06	
MYI 0.969885		ERSFAC 1 33.207164						
90	5.9298E-04	5.3113E-05	-0.85607740	0.95740521	1.04448983	-8.1072E-05	1.2198E+06	
91	5.9850E-04	5.0568E-05	0.95208857	0.95740902	1.04448567	-4.1576E-06	1.2199E+06	SAVING O UX AND KEFF
92	5.6545E-04	5.2582E-05	1.03982699	0.95736966	1.04452861	4.2937E-05	1.2200E+06	
93	5.2375E-04	4.9263E-05	0.93606918	0.95738581	1.04451099	-1.7624E-05	1.2201E+06	
94	5.0865E-04	4.5445E-05	0.92249309	0.95740694	1.04448793	-2.3051E-05	1.2201E+06	
95	4.9142E-04	4.4615E-05	0.96613473	0.95739432	1.04450171	1.3774E-05	1.2202E+06	
96	4.6152E-04	4.3505E-05	0.97086379	0.95739038	1.04450599	4.2806E-06	1.2203E+06	SAVING OF FLUX AND KEFF
97	4.3942E-04	4.0707E-05	0.93559749	0.95740253	1.04449275	-1.3238E-05	1.2203E+06	
98	4.2372E-04	3.8949E-05	0.95682999	0.95740383	1.04449133	-1.4199E-06	1.2204E+06	
99	4.0321E-04	3.7797E-05	0.97041825	0.95739952	1.04449603	4.7002E-06	1.2205E+06	
100	3.8258E-04	3.5938E-05	0.95000696	0.95740319	1.04449202	-4.0091E-06	1.2206E+06	
101	3.6655E-04	3.4097E-05	0.94878200	0.95740711	1.04448775	-4.2723E-06	1.2206E+06	SAVING OF FLUX AND KEFF

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A.E.K. PROGRAM NO. 25     PROBLEM NO. 25    8/11.1977          12/11-1977.    0.01
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD                  PROCESSOR   =  1044 SEC
                                                                ELAPSED     =-04938 SEC
                                                                INPUT/OUTPUT=   136 SEC


THE POWER ITERATION IS FINISHED
KEFF=     1.04444877509
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12/11-1977. 9:01
PROCESSOR = 1097 SEC
ELAPSED =-0837 SEC
INPUT/OUTPUT= 136 SEC

A.E.K. PROGRAM NO. 25 PROBLEM NO. 25 8/11.1977
FLUX CALCULATIONS BY THE FINITE ELEMENT METHOD

THE CALCULATED FLUX-DISTRIBUTION IS

FLUX IN GROUP 1 IN THE PLANE Z= 3800.

1700.:	75.	72.	70.	29.	-26.	0.	0.	0.	0.	0.
1500.:	-87.	-60.	-87.	-16.	85.	17.	-10.	0.	0.	0.
1300.:	-145.	-139.	-155.	-131.	-73.	-12.	39.	-19.	0.	0.
1100.:	-102.	-99.	-107.	-120.	-129.	-97.	-0.	30.	-10.	0.
900.:	-13.	-40.	-86.	-63.	-18.	-40.	-97.	-12.	17.	0.
700.:	2.	-19.	-63.	-69.	-18.	-18.	-129.	-75.	85.	-28.
500.:	-44.	-44.	1.	-1.	-64.	-64.	-120.	-131.	-18.	30.
300.:	-35.	-37.	5.	1.	-93.	-86.	-107.	-155.	-87.	70.
100.:	-9.	-16.	-37.	-46.	-19.	-40.	-99.	-130.	-79.	73.
0.:	7.	-8.	-35.	-46.	7.	-10.	-102.	-145.	-87.	75.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 1 IN THE PLANE Z= 3600.

1700.:	-83.	-74.	-87.	-92.	57.	0.	0.	0.	0.	0.
1500.:	1593.	1576.	1546.	733.	-131.	-13.	31.	0.	0.	0.
1300.:	2761.	2729.	2736.	2257.	1303.	548.	-67.	42.	0.	0.
1100.:	2326.	2361.	[illegible]	2460.	2150.	1493.	459.	-67.	31.	0.
900.:	1551.	1402.	1501.	1873.	1283.	1310.	1094.	508.	-111.	9.
700.:	734.	870.	1277.	1339.	1020.	1265.	2153.	1385.	-71.	37.
500.:	865.	835.	523.	644.	1391.	1876.	2463.	2259.	713.	-48.
300.:	723.	685.	376.	524.	1279.	1904.	2464.	2737.	1694.	-87.
100.:	455.	507.	697.	838.	872.	1494.	2362.	2725.	1576.	-74.
0.:	373.	456.	730.	670.	740.	1226.	2325.	2740.	1597.	-80.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 1 IN THE PLANE Z= 2800.

1700.:	-237.	-211.	-263.	-173.	217.	0.	0.	0.	0.	0.
1500.:	5661.	5579.	5418.	3815.	-471.	-61.	133.	0.	0.	0.

1300.	7724.	7086.	7919.	7400.	5233.	2316.	[illegible]	177.	0.	0.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.	1625.	1604.	2466.	3768.	2547.	3413.	5007.	7763.	5677.	-230.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 1 IN THE PLANE Z= 900.

1700.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.	1615.	1897.	2403.	2668.	1734.	1653.	3100.	3585.	[illegible]	-107.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 1 IN THE PLANE Z= 0.

1700.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	0.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
0.	16.	-32.	-105.	-111.	-13.	-23.	-133.	[illegible]	[illegible]	107.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 2 IN THE PLANE Z= 3000.

1700.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	0.	0.
1500.	300.	207.	201.	136.	-64.	-6.	0.	0.	0.	0.

1300.!	564.	562.	568.	437.	257.	94.	-28.	20.	0.	0.
1100.!	513.	500.	512.	506.	461.	307.	71.	-28.	9.	0.
900.!	167.	262.	403.	405.	206.	215.	308.	94.	-6.	0.
700.!	85.	157.	273.	294.	167.	208.	462.	257.	-68.	27.
500.!	193.	184.	94.	116.	295.	405.	507.	437.	130.	-17.
300.!	151.	146.	67.	95.	273.	404.	513.	568.	291.	-55.
100.!	78.	97.	148.	164.	157.	262.	500.	562.	297.	-53.
0.!	23.	74.	151.	195.	85.	162.	510.	564.	309.	-56.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 2 IN THE PLANE Z= 3600.

1700.!	312.	301.	289.	125.	-103.	0.	0.	0.	0.	0.
1500.!	1361.	1401.	1096.	1372.	437.	54.	-32.	0.	0.	0.
1300.!	801.	836.	753.	1154.	1260.	943.	200.	-80.	0.	0.
1100.!	895.	866.	945.	837.	574.	663.	1064.	200.	-32.	0.
900.!	293.	446.	665.	661.	446.	306.	684.	944.	54.	0.
700.!	173.	274.	484.	517.	261.	446.	575.	1261.	432.	-103.
500.!	333.	335.	130.	166.	517.	662.	638.	1155.	1373.	125.
300.!	265.	276.	89.	131.	464.	666.	946.	750.	1098.	289.
100.!	143.	172.	278.	336.	275.	447.	666.	836.	1399.	301.
0.!	54.	140.	266.	334.	171.	293.	695.	801.	1359.	311.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 2 IN THE PLANE Z= 2800.

1700.!	1149.	1111.	1091.	545.	-406.	0.	0.	0.	0.	0.
1500.!	3643.	3806.	2699.	4540.	1707.	255.	-150.	0.	0.	0.
1300.!	1187.	1289.	1056.	2554.	3565.	3260.	673.	-340.	0.	0.
1100.!	1497.	1442.	1637.	1418.	798.	1475.	3790.	873.	-150.	0.
900.!	522.	748.	1051.	1130.	928.	594.	1475.	3280.	255.	0.
700.!	353.	535.	628.	865.	470.	928.	797.	3567.	1708.	-406.
500.!	631.	620.	586.	653.	885.	1130.	1418.	2556.	4545.	545.
300.!	534.	541.	514.	566.	826.	1050.	1638.	1058.	2906.	1093.
100.!	303.	376.	540.	618.	533.	747.	1444.	1292.	3819.	1114.
0.!	141.	303.	533.	629.	357.	522.	1499.	1164.	3652.	1151.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 2 IN THE PLANE Z= 200.

1700.!	453.	438.	425.	197.	-158.	0.	0.	0.	0.	0.
1500.!	1674.	1737.	1339.	1884.	661.	91.	-55.	0.	0.	0.

1300.I	786.	835.	727.	1336.	1627.	1347.	324.	-128.	0.	0.
1100.I	965.	932.	1020.	903.	580.	798.	1553.	324.	-55.	0.
900.I	388.	556.	601.	816.	573.	373.	797.	1346.	91.	0.
700.I	343.	504.	749.	759.	419.	572.	580.	1621.	658.	-158.
500.I	709.	692.	766.	781.	760.	815.	901.	1330.	1874.	196.
300.I	677.	673.	749.	767.	750.	800.	1024.	723.	1328.	422.
100.I	389.	491.	674.	694.	505.	555.	927.	830.	1721.	433.
0.I	187.	389.	670.	710.	344.	363.	962.	781.	1658.	449.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

FLUX IN GROUP 2 IN THE PLANE Z= 0.

1700.I	-83.	-76.	-63.	-26.	43.	0.	0.	0.	0.	0.
1500.I	444.	429.	426.	202.	-108.	-13.	17.	0.	0.	0.
1300.I	767.	757.	772.	627.	401.	157.	-49.	33.	0.	0.
1100.I	657.	666.	708.	715.	635.	440.	127.	-49.	17.	0.
900.I	473.	490.	616.	600.	454.	453.	440.	157.	-13.	0.
700.I	419.	440.	585.	561.	451.	454.	634.	399.	-107.	43.
500.I	511.	525.	579.	590.	561.	599.	713.	624.	201.	-28.
300.I	507.	510.	565.	560.	565.	615.	706.	768.	423.	-82.
100.I	385.	400.	518.	526.	440.	469.	665.	752.	425.	-78.
0.I	371.	386.	508.	512.	419.	469.	649.	762.	440.	-82.
	0.	100.	300.	500.	700.	900.	1100.	1300.	1500.	1700.

TIME USED FOR THIS PROBLEM
PROCESSOR = 1046 SEC
ELAPSED =-84934 SEC
INPUT/OUTPUT = 137 SEC

TIME USED FOR THIS TASK PROCESSOR = 1046 SEC ELAPSED =-84934 SEC INPUT/OUTPUT = 137 SEC